C-NAVY-01-06-2034W

January 10, 2006

Project Number G00200

Mr. Curtis Frye Remedial Project Manager EFA Northeast, Naval Facilities Engineering Command 10 Industrial Highway, Mail Stop 82 Lester, Pennsylvania 19113

Reference:

CLEAN Contract No. N62472-03-D-0057

Contract Task Order (CTO) No. 043

Subject:

Draft Final NAPL Position Paper

Naval Station Newport, Newport, Rhode Island

Dear Mr. Frye:

Enclosed for your review and comment are two copies of the Draft Final "Evaluation of Non-aqueous Phase Liquid Presence and Remediation Requirements at Naval Station Newport, Newport, Rhode Island". As directed by you, two copies of the draft final paper are being sent to Cornelia Mueller under separate distribution. We will produce a final version of the paper upon receipt of your comments.

Very truly yours,

Heather M. Ford Project Manager

HMF/rp

Enclosures

C:

C. Mueller, NAVSTA (w/encl. - 2)

J. Trepanowski/G. Glenn, TtNUS (w/o encl.)

S. Parker/D. Baxter, TtNUS (w/o encl.)

File G00200-3.2 (w/o encl.)/File G00200-8.0 (w/encl.)

EVALUATION OF NON-AQUEOUS PHASE LIQUID PRESENCE AND REMEDIATION REQUIREMENTS AT NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND

ABSTRACT

Information regarding the presence and regulation of non-aqueous phase liquid (NAPL) in subsurface media has been evaluated to determine whether, or under what conditions, the presence of oil in the subsurface at Naval Station Newport (NAVSTA) sites constitutes an actionable condition based on the Rhode Island Department of Environmental Management's (RIDEM's) environmental regulations. This evaluation was necessitated by a continuing difference of opinion between the Navy and RIDEM regarding the potential presence and required remediation of NAPL at NAVSTA sites.

Environmental data and evaluations at NAVSTA demonstrate that residual oil can be present in subsurface soils near and below the water table without the oil being mobile or being a significant continuing source of groundwater contamination. Therefore, residual oil can be present in the soils without presenting a risk of exposure to downgradient receptors (i.e., groundwater, surface water, or marine life). Additionally, observations made during groundwater sampling demonstrate that an oil sheen can be generated by aggressively purging groundwater from a well located in soils containing relatively low concentrations (<200 mg/kg) of total petroleum hydrocarbons (TPH), even when a sheen was not present under steady-state conditions.

These observations are also supported by scientific literature on the behavior of NAPL in the subsurface (API, 2002; LSPA, 2005). Over time, a NAPL mass in the subsurface may be depleted by dissolution, volatilization, entrapment, and other mechanisms. As a result of these processes, the fraction of the soil pore space occupied by NAPL decreases, and its mobility is reduced, until ultimately the NAPL is present only as isolated, discontinuous, immobile masses that are held in place by the capillary pressure of the soil matrix. Under steady-state conditions, the residual oils are not mobile. However, when the soil matrix is broken, some residual oil may remobilize (and be visible as a sheen or seep) until it is recaptured and held by the capillary pressure of the soil matrix.

The State of Rhode Island regulations governing the presence and remediation of NAPL in environmental media at contaminated sites are the *Rules and Regulations for the Investigation and Remediation of Hazardous Materials Release*, short title: Remediation Regulations (DEM-DSR-01-93; 1993, amended 1996 and 2004). The Remediation Regulations, in Section 3.43, define NAPL as "an organic compound present at concentrations such that it exists as a separate phase in equilibrium with water." Further, the regulations, in Section 8.07A, state that "The presence of non-aqueous phase liquids (NAPL) in any

environmental medium shall be considered a condition that exceeds Upper Concentration Limits" (UCLs). UCLs in soil or groundwater are defined in this section of the regulations as "concentrations of hazardous substances which, if exceeded, may demarcate a transition between contaminated environmental media and waste in the environment." However, the regulations do not include a numeric concentration or other objective criteria at which a substance is considered to be NAPL, nor do they define remediation standards or requirements for NAPL or provide a framework for determining when a NAPL remediation would be considered complete. These distinctions are left to the regulators or public to determine.

Based on the definition provided in Section 3.43 of the Remediation Regulations, we conclude that residual oil contamination should be considered to be NAPL only if a clearly defined separate phase liquid is observed on groundwater or surface water under equilibrium conditions. Applying this definition, residual oil present in soil does not constitute NAPL when a separate phase liquid has been observed on groundwater only when the equilibrium conditions have been disturbed (i.e. by excavation). Similarly, an oil sheen observed in bailed groundwater does not constitute NAPL when a sheen is observed only in response to aggressive purging.

RIDEM has consistently maintained that the presence of a sheen in test pit excavations and the presence of oily soil at and below the water table at NAVSTA sites do constitute NAPL, and that this presence of NAPL constitutes an exceedence of the UCLs under Section 8.07A of the Remediation Regulations. These statements have been made in reference to several NAVSTA sites including the Old Fire Fighting Training Area (OFFTA), the former Melville North Landfill, and the Tank Farms. RIDEM personnel have asserted that RIDEM consistently enforces these interpretations of the Remediation Regulations for NAPL contamination, both at NAVSTA and elsewhere in the state (TtNUS, 2005a). However, because the observation of petroleum "stains" or "sheens" are subject to interpretation by the observer and may not always be noted in field records and reports, and RIDEM personnel can not be present to oversee all site investigations in the state and observe these conditions first-hand, it is unlikely that the Remediation Regulations for NAPL could be consistently enforced at sites across the state based on the presence of a sheen or petroleum staining.

Although the consistency of their enforcement of the Remediation Regulations across the state is uncertain, RIDEM has consistently applied this broad, conservative definition of NAPL in their enforcement of the regulations at NAVSTA. Due to RIDEM's application of this broad definition of NAPL presence at NAVSTA and the lack of objective, measurable cleanup standards for NAPL in the Remediation Regulations, the end-point in any potential removal of oil-contaminated soil at NAVSTA would be subjective and would remain uncertain even after all oily soils were removed to a predetermined cleanup level. Therefore, before proceeding with any remediation at NAVSTA to address oil-contaminated soil, clear and measurable endpoints must be established.

1.0 INTRODUCTION

This paper is an evaluation of information regarding the presence, determination, and regulation of non-aqueous phase liquid (NAPL) at Naval Station Newport (NAVSTA) sites. The evaluation was deemed necessary due to the different views held by the Navy and the Rhode Island Department of Environmental Management (RIDEM) regarding the potential presence of NAPL at several NAVSTA sites. Specifically, the presence of certain conditions in subsurface soil, groundwater and surface water are judged by RIDEM to indicate the presence of NAPL that requires remediation; however, the Navy does not agree that these conditions are evidence of a presence of NAPL that requires remediation in accordance with RIDEM regulations. This paper has been prepared to review RIDEM's regulations governing NAPL in order to determine how NAPL is defined and regulated; to consider the various conditions that have been identified by RIDEM as indicating the presence of NAPL at NAVSTA sites and evaluate whether they are valid indicators of NAPL requiring remediation; and to make recommendations for potential future actions to address residual oil contamination at NAVSTA sites.

Information reviewed for this evaluation included scientific papers about the presence and behavior of NAPL in subsurface media (including API 2002 and 2003; DNREC 2004; and LSPA 2005); RIDEM regulations governing NAPL in subsurface media; site data for the OFFTA and former Melville North Landfill sites at NAVSTA; and RIDEM case files for three non-Navy sites in Rhode Island. The OFFTA and former Melville North Landfill sites are used as examples in this evaluation; however, the conclusions of this evaluation apply broadly to petroleum contamination at NAVSTA.

This paper includes the following components: this introduction; background on NAPL behavior in the subsurface (Section 2.0); discussion of the RIDEM regulations that govern remediation of NAPL (Section 3.0); evaluation of RIDEM's enforcement of those regulations (Section 4.0); description of the conditions related to residual petroleum presence in the subsurface at two NAVSTA sites and evaluation of whether these conditions indicate the presence of NAPL (Section 5.0); and finally, conclusions and recommendations for potential future actions to address residual oil contamination at NAVSTA sites (Section 6.0).

2.0 BACKGROUND - NAPL BEHAVIOR IN THE SUBSURFACE

This section provides a brief technical background for the discussion of the regulation and identification of NAPL at NAVSTA sites. There are two types of NAPLs: light NAPL (LNAPL) and dense NAPL (DNAPL). The focus of this section is on the behavior of LNAPLs because they are the NAPLs of primary concern at NAVSTA, due to past petroleum releases. DNAPLs are regulated in the same manner as LNAPLs, but they behave somewhat differently in the subsurface. DNAPLs are not discussed in this paper.

The scientific understanding of the behavior of LNAPL in the subsurface has evolved in recent years from a simplistic model which assumed that LNAPL floated as a separate layer on groundwater, completely filling the soil pore spaces in a continuous mass, to the current conceptual model, referred to as the "multi-phase flow" model, which recognizes that LNAPL does not "float" as a continuous layer on top of the water table, but rather exists along with water and air within a network of soil pores above and below the water table. In the multi-phase flow system, the mobility of LNAPL is strongly impacted by the presence and relative saturation of other fluids, particularly water, in the soil matrix. The multi-phase flow model is documented by the American Petroleum Institute (API, 2002, 2003) and is briefly described below.

In unsaturated soils above the groundwater zone, where soil pores are filled with air and some water, the water is preferentially attracted to the solids and forms a continuous coating around the soil grains and may fill the smaller pore spaces. When an LNAPL is released to the subsurface, it migrates downward under the force of gravity. As it moves through the unsaturated zone, LNAPL partially displaces the air in the soil pores, while the water remains as a coating on the solids and in some smaller pore spaces. If a sufficient volume of LNAPL is present, it will continue to migrate downward until it encounters a physical barrier (e.g., a lower permeability soil) or reaches the groundwater zone (capillary and saturated zones) where it will begin to spread laterally, as the water in the soil pores provides some resistance to vertical flow.

Within the saturated zone, LNAPL partially displaces water, filling the interiors of the larger soil pores and forming a continuous network of interconnected pores containing LNAPL. Water remains as a coating on the solids and occupies the margins of the larger pore spaces. Movement of LNAPL within the groundwater zone is constrained by the pressure needed to displace water from the soil pores. The LNAPL continues to migrate laterally and downward, finding flow paths through sequences of larger pore spaces, until it lacks sufficient pressure to continue. The smaller pore spaces may remain filled with water if the LNAPL lacks the entry pressure to displace the water.

After the LNAPL release ceases, subsurface spreading of the LNAPL slows and ultimately stops when it lacks the pressure gradient to continue migration and the plume reaches an equilibrium condition. At this point, the soil pores within the plume are occupied by LNAPL, water, and air in various proportions depending on the location within the plume, the characteristics of the soil (i.e. grain size, porosity, etc.), and the viscosity of the LNAPL. After the plume has reached its maximum horizontal extent, LNAPL may continue to move vertically as the water table rises and falls, spreading or smearing the LNAPL within the region around the water table. As the water table fluctuates, the mobility of the LNAPL changes in response to changes in the capillary pressures and saturation profile (fraction of air, water, and LNAPL) of

the soil pores. During periods of high water table elevations, LNAPL may become trapped as discontinuous masses beneath the water table. During low water table elevation periods, previously entrapped LNAPL may drain from now exposed unsaturated soils to again form a continuous LNAPL mass.

Over time, the more soluble components of the LNAPL dissipate as a result of contaminant dissolution into groundwater. Similarly, the more volatile components of the LNAPL also dissipate into the air as a result of contaminant volatilization into soil gas. The remaining LNAPL will consist largely of lower solubility, less volatile compounds that have a low tendency to migrate or impact downgradient receptors. As LNAPL is depleted in the subsurface, the fraction of pore space occupied by LNAPL decreases and the LNAPL-occupied flow paths become smaller and more scarce, continually decreasing the mobility of the LNAPL. Ultimately, the remaining LNAPL breaks into isolated, discontinuous, immobile masses. The point at which the LNAPL becomes discontinuous, and therefore immobile, is referred to as residual saturation.

LNAPL recovery from a well or trench is possible only when the LNAPL is present at sufficient saturation in a network of interconnected pores so that it can be mobilized by a natural or induced gradient. When LNAPL is present at residual saturation, existing only in isolated, discontinuous masses, it can not be recovered in liquid form, even under an induced gradient (i.e. pumping or vacuum extraction).

3.0 RIDEM REGULATIONS GOVERNING NAPL

The State of Rhode Island regulations governing the presence and remediation of NAPL were evaluated to determine how NAPL is defined and regulated in the state and whether oil residuals present at NAVSTA should be considered as NAPL under the state regulations. The Rhode Island regulations governing the presence and remediation of NAPL in environmental media at contaminated sites are the Rules and Regulations for the Investigation and Remediation of Hazardous Materials Release, short title: Remediation Regulations (DEM-DSR-01-93; 1993, amended 1996 and 2004). The following three sections of the regulations pertain to the presence of NAPL (the RIDEM regulations do not differentiate between LNAPL and DNAPL).

Section 3.43 of the Remediation Regulations includes the following definition:

"Non-Aqueous Phase Liquid (NAPL) shall mean an organic compound present at concentrations such that it exists as a separate phase in equilibrium with water."

This Section of the Remediation Regulations does not include a concentration or other objective criteria at which a substance is considered to be NAPL. Thus, it can either be construed as describing a "definable" separate phase (i.e. measurable), or any type of "observed" separate phase. An "observed" separate

phase, such as a slight or heavy sheen, is a qualitative determination that is not easily, consistently enforceable, particularly if it is observed sporadically or only under non-equilibrium conditions (i.e. agressive purging or excavation).

<u>Section 8.01</u> of the Remediation Regulations identifies the overall remedial objectives for hazardous substances in all impacted media at contaminated sites. This section specifies the following requirements:

- A. The remedial objective for each carcinogenic substance does not exceed 1 X 10⁻⁶ excess lifetime cancer risk and the cumulative excess lifetime cancer risk posed by the contaminated site does not exceed 1 X 10⁻⁵;
- B. The remedial objective for each non-carcinogenic substance does not exceed a hazard index of 1 and the cumulative hazard index posed by the contaminated site does not exceed 1 for any target organ;
- C. The remedial objective will not significantly contribute to adverse effects to any environmentally sensitive areas at, or in the vicinity of, the contaminated site;
- D The remedial objective will be protective of the natural resources of the State, including, but not limited to groundwater; and
- E. The remedial objective shall address the requirements of Rule 8.07 (Upper Concentration Limits).

<u>Section 8.07</u> of the Remediation Regulations defines Upper Concentration Limits (UCLs) in soil and groundwater as concentrations of hazardous substances which, if exceeded, may demarcate a transition between contaminated environmental media and waste in the environment. It further states that all remedial objectives must address concentrations or conditions identified in Section 8.07, paragraphs A through D.

Paragraph 8.07A states: "The presence of non-aqueous phase liquids (NAPL) in any environmental medium shall be considered a condition that exceeds Upper Concentration Limits".

At NAVSTA sites, RIDEM personnel have consistently cited Section 8.07A of the Remediation Regulations when identifying "actionable conditions" pertaining to perceived NAPL presence. As noted above, this section states that the presence of NAPL in any environmental medium is considered a condition that exceeds UCLs, but the section provides no further definition of NAPL. RIDEM personnel overseeing activities at NAVSTA appear to define NAPL broadly as ANY presence of oil – including a thin coating on soil grains, or a slight sheen on purged groundwater. However, the definition of NAPL provided in Section 3.43 of the Remediation Regulations appears to narrow the range of conditions that would be considered NAPL to include only separate-phase liquids observed in water under equilibrium conditions. Applying this definition, an oil seep or sheen observed only under non-equilibrium conditions (i.e. when the soil matrix was broken or the groundwater disturbed by purging) should not be considered NAPL because a NAPL was not present in water under equilibrium conditions.

The Remediation Regulations do not define remediation standards or requirements for NAPL and do not provide a framework for determining when a NAPL remediation would be considered complete. During a meeting at NAVSTA in February 2005, regarding potential excavation of petroleum-contaminated soil at the OFFTA site, RIDEM personnel stated that RIDEM's policy is to require that attempts be made to remove all contaminated soil, to a TPH concentration of 500 ppm. Then, if it is not logistically possible to remove all soils with TPH greater than 500 ppm, recovery wells or trenches must be installed and attempts made to collect NAPL using bailers or skimmers, or, if just a sheen is present, oxidant must be added (TtNUS, 2005b). Based on the language of the Remediation Regulations and this stated RIDEM policy, the end-point in any potential removal of oil-contaminated soil would be subjective and would remain uncertain even after the oily soils were removed to a pre-determined acceptable level. The post-removal developments at the former Melville North Landfill (described in Section 5.2 of this paper) clearly illustrate this point.

4.0 ENFORCEMENT OF RIDEM NAPL REGULATIONS AT OTHER SITES

RIDEM has stated on several occasions that oily soil found at and below the water table at NAVSTA constitutes "free product" (NAPL) and that the presence of "free product" is an actionable condition under RIDEM Remediation Regulations Section 8.07A. RIDEM has also maintained that the presence of a sheen constitutes NAPL, and its presence constitutes an exceedence of the UCLs (Remediation Regulations Section 8.07A). These statements have been made in reference to the presence of oily soil and sheens at several NAVSTA sites, including OFFTA, the former Melville North Landfill, Tank Farm Four (Site 12), and Tank Farm Five (Site 13). RIDEM personnel have asserted that RIDEM consistently enforces these interpretations of Section 8.07 of the Remediation Regulations for NAPL contamination, both at NAVSTA and elsewhere in the state (TtNUS, 2005a).

A limited file review was conducted at the RIDEM Waste Management office on August 11, 2005 to find evidence of whether the Remediation Regulations pertaining to NAPL have been consistently applied at other sites in the same manner as RIDEM has interpreted and applied them for sites at NAVSTA. The files from three Rhode Island waste sites were selected for review. Agency Realty (Carroll Products) in Wood River Junction; and Aqua Tank Farm at Quonset Point/Davisville, North Kingston were selected because they are oil release sites where remediation of NAPL was required. The Sunshine Island/Fields Point Parcel in Providence was selected for review because of its former use as a municipal landfill where various types of waste were disposed directly into the Providence River. The land is being redeveloped for educational outreach programs.

The files for the first two sites indicated the consistent presence of a measurable thickness (greater than 0.01 feet) of separate-phase oil in site monitoring wells. At the Carroll Products site, approximately 250 gallons of oil had been recovered from monitoring and recovery wells from 1994 to 2001, and recovery

efforts were ongoing in March 2001 (GZA, 2001)(more recent data were not found in the files). At the Aqua Tank Farm site, investigation was still ongoing to determine the extent of NAPL contamination and potential remedial alternatives. In both cases RIDEM had issued Notices of Violation (of the Underground Storage Tank Regulations and/or the Remediation Regulations) in part due to the presence of NAPL. Correspondence from RIDEM contained in the files for these sites does not mention the presence of sheens or cite sheens as being an indication of the presence of NAPL. The files for the Sunshine Island site did not include any mention of NAPL, although occurrence of sheens would not be unusual at a former landfill site.

Although the limited file review of these sites indicated that RIDEM actively enforced regulations pertaining to obvious NAPL presence (i.e. presence of distinct layers of measurable oil in wells), the files evaluated did not provide any evidence of RIDEM characterizing the presence of a sheen as an indication of NAPL. The two confirmed LNAPL sites evaluated both had measurable amounts of oil consistently present in site monitoring wells – a condition that has not occurred at the NAVSTA sites.

As there was no identification of petroleum sheens or staining being indicative of NAPL presence at any of the three parcels evaluated, this limited file review does not indicate that RIDEM is, or is not, consistent in their interpretation and enforcement of the NAPL regulations and policy described above. An exhaustive search of all RIDEM Waste Management site files would be necessary to show a pattern of consistency or inconsistency in this regard. However, even such a search would not result in conclusive evidence of enforcement consistency because the observation of petroleum "stains" or "sheens" are subject to interpretation by the observer and may not always be noted in field records. Since RIDEM personnel are not present at all (or even most) sites during field investigations, field records and reports are the only means that RIDEM has to evaluate the conditions at most sites. Without descriptive and accurate field records and the uniform presence of regulatory oversight, such qualitative parameters as the presence of petroleum sheens or stains are impossible to consistently enforce.

5.0 RESIDUAL OIL CONTAMINATION AT SELECTED NAVSTA SITES

Field observations and chemical analysis of site environmental media at two NAVSTA sites are discussed in this section to 1) provide an understanding of the presence and potential impacts of residual oil in the subsurface; 2) describe the conditions identified by RIDEM as indicative of NAPL presence; and 3) evaluate whether the residual oil constitutes NAPL as defined in RIDEM regulations. These sites are used here as case studies; however, the conditions observed with respect to potential NAPL presence are representative of other NAVSTA sites where residual petroleum is present in subsurface soils.

5.1 Old Fire Fighting Training Area (OFFTA) Site

RIDEM has identified certain conditions at the OFFTA site, including the presence of oily soil, and sheens on groundwater in test pits, that they believe indicate NAPL presence and constitute an exceedence of the UCLs (Section 8.07 of the Remediation Regulations) (TtNUS, 2005b). Based on the evaluation of the RIDEM Remediation Regulations presented above, the Navy disagrees with RIDEM's interpretation that these conditions indicate NAPL presence that exceeds UCLs and therefore requires remedial action under the Remediation Regulations. The following sections describe the conditions related to presence of residual oil contamination at the OFFTA site and present the Navy's rationale for concluding that the residual oil contamination does not constitute NAPL requiring cleanup under the Remediation Regulations.

Conditions Relating to Residual Oil Presence at OFFTA

Evidence of petroleum contamination (oil-stained or oil-saturated soils and petroleum odors in soils near the water table) has been observed in site subsurface soils at several boring and test pit locations, primarily in the central and eastern portion of the site. Logs from several boring and test pit locations also note the presence of a sheen on groundwater from the boring or in the test pit. In one test pit (TP-17), a limited amount of oil was observed seeping from the side of the excavation and pooling on the water table surface. RIDEM has stated that oily soil and sheens observed in test pits at the site indicate the presence of NAPL (TtNUS 2005a, 2005b).

The oil seepage noted at TP-17 was the only instance where boring or test pit logs indicate the potential presence of oil seepage or an oil layer floating on the water table (as opposed to a sheen). The seepage of oil into the test pit likely resulted because disturbance of the soil in the excavation altered the capillary pressure of the soils at that location, allowing a small mass of oil that was previously trapped within the soils to seep (i.e. because soils were removed, the mass of residual oil was no longer constrained by capillary pressure in adjoining soil pores so it was free to seep into the open pit).

No measurable NAPL (LNAPL or DNAPL) has ever been detected in any of the groundwater monitoring wells at the OFFTA site. The 13 on-site wells have been tested for the presence of NAPL using an oil/water interface probe on five occasions from 1990 through 2004.

Groundwater analytical results from 1994 through 2004 show the presence of only low concentrations of a few volatile organic compounds (VOCs) and a few semi-volatile organic compounds (SVOCs), primarily polynuclear aromatic hydrocarbons (PAHs). Contaminants have

not been detected at concentrations close to those considered indicative on NAPL presence (i.e. 1 percent of the pure phase solubility of the detected compounds)

No oil sheen or oil seepage has been observed in surface water or sediment along the shoreline adjacent to the site during any of the documented site investigations.

Conclusion: Potential NAPL Presence at OFFTA

Based on field observations and soil analytical data it appears that residual oil contamination is present in soils in the central and shoreline areas of the OFFTA site. However, based on the interpretation presented in Section 3.0 of what constitutes NAPL according to RIDEM Remediation Regulations, the residual oil present at OFFTA <u>does not</u> constitute NAPL because a separate-phase liquid has not been observed on groundwater or surface water at the site under equilibrium conditions.

The following factors support this conclusion, as well as the conclusion that the residual oil in the subsurface at the site is not mobile, and is not a significant continuing source of contamination to groundwater, surface water, or sediment:

- Records indicate that the last release of oil at the site occurred more than 30 years ago (prior to 1974).
- Measurable oil has never been observed in any of the wells on site, including those within the
 area where oily soils and high petroleum hydrocarbon concentrations have been identified near
 the water table.
- Groundwater samples from the site do not show a significant presence of dissolved oil constituents that would be indicative of NAPL presence.
- No oil sheen or oil seepage has been observed in surface water or sediment along the shoreline adjacent to the site during site investigations.

5.2 Former Melville North Landfill Site

RIDEM has identified conditions at the former Melville North Landfill site, that they believe indicate NAPL presence and constitute an exceedence of the UCLs (Section 8.07 of the Remediation Regulations). Based on the evaluation of the RIDEM Remediation Regulations presented above, the Navy disagrees with RIDEM's interpretation that these conditions indicate NAPL presence that exceeds UCLs and therefore requires remedial action under the Remediation Regulations. The following paragraphs describe the conditions related to presence of residual oil contamination at the former Melville North Landfill site and present the Navy's rationale for concluding that the observed conditions do not constitute NAPL requiring cleanup under the Remediation Regulations.

A removal action was completed at the former landfill in May 2000. This action involved excavation and off-site disposal of all contaminated soils and debris to agreed-upon action limits (including a TPH action limit of 500 mg/kg). Groundwater monitoring wells were installed on site following the removal action to facilitate monitoring of groundwater to confirm completion of the removal action. During two of three subsequent groundwater monitoring events, a sheen was noted in the purge water generated during bailer-sampling of one of the wells, which was located in an area where oily soil exceeding the agreed-upon action limits had been removed. The sheen was noted at this location only in purge water generated by bailing. No sheens were noted in purge water generated during low-flow sampling of this or other site wells, and no presence of LNAPL was detected with an oil-water interface probe in any of the wells (TtNUS, 2004).

Similar to the OFFTA site, some soils containing residual petroleum contaminants remain at the former Melville North Landfill site, although TPH concentrations are below the agreed upon action limit of 500 mg/kg (a maximum of 190 mg/kg TPH was measured in soil from the boring for the well where the sheen was observed on purge water). Even though residual TPH concentrations are low, the aggressive sampling of the well using a bailer produced a sheen on the purged groundwater. This observation indicates that sheens in groundwater can be generated from soils that contain even relatively low concentrations of petroleum hydrocarbons when the natural equilibrium is disturbed by aggressive actions. This also indicates that a sheen in groundwater could be generated under soil petroleum concentrations below RIDEM's residential soil direct exposure criteria that pose no threat to human health or the environment.

RIDEM has taken the position that the sheen noted in the bailer purge water from the monitoring well at the former Melville North Landfill site is NAPL. RIDEM has notified the Navy that the site is not in compliance with its Site Remediation Regulations and Oil Pollution Control Regulations for a variety of reasons. One of the conditions of compliance that RIDEM has identified is that the Navy must show that "free product" is not present during four consecutive groundwater sampling rounds conducted to capture the season(s) which exhibit the highest concentrations of contaminants, or if seasonal fluctuations in contaminant concentrations are not evident, to capture all seasons (RIDEM, 2005).

The Navy disagrees with RIDEM's conclusions and maintains that the sheen observed in the bailer purge water was present only due to aggressive purging of the well (a non-equilibrium condition), and does not constitute NAPL as defined in the RIDEM Remediation Regulations. The Navy believes that the removal action at the former Melville North Landfill is complete. However, RIDEM's position on NAPL presence prevents formal closure of the removal action.

6.0 CONCLUSIONS AND RECOMMENDATIONS

This section summarizes conclusions of this NAPL evaluation and provides recommendations for potential future actions to address residual oil contamination at NAVSTA sites.

6.1 Conclusions

This section presents the conclusions of the NAPL evaluation regarding the conditions RIDEM considers to be indicators of NAPL presence; the Navy's interpretation of what constitutes NAPL presence under the RIDEM Remediation Regulations; and RIDEM's interpretation and enforcement of the Remediation Regulations regarding NAPL.

Limitations of NAPL Indicators Used by RIDEM

As demonstrated by conditions at the NAVSTA sites, residual oil can be present in soil pores without the oil being mobile or being a significant continuing source of groundwater contamination. Therefore, residual oil can be present in the soils without presenting a risk of exposure to downgradient receptors (i.e., groundwater, surface water, or marine life). In such cases, the residual oil would only pose a threat if direct exposure to the contaminants in the oil posed a health risk.

Observations during investigations at NAVSTA sites demonstrate that sheens can be developed from soil containing residual oil even at relatively low TPH concentrations if the steady-state condition of the soil is disturbed by actions such as excavation or aggressively purging a groundwater monitoring well. This fact along with the subjectivity of the identification of and inconsistent reporting of sheens in field investigation records underscore the conclusion that the determination of NAPL presence and the enforcement of the UCL for NAPL (Section 8.07 of the Remediation Regulations) based on the presence of a sheen are both impractical and scientifically unsound. Because the observation of a sheen is subjective and inconsistently reported, and RIDEM personnel can not be present to oversee all site investigations in the state, it is unlikely that there could be consistent enforcement of the Remediation Regulations for NAPL based on the presence of a sheen.

The presence of a sheen is not a reliable indicator of NAPL. Further, in most cases, remediating soils with residual petroleum to a level that would guarantee that no sheen will ever be present on associated groundwater is technically impracticable. Thus, if any presence of a sheen is considered to be a NAPL, the Navy could conduct extensive remediation at a site and remove all contamination posing a potential threat to humans or the environment and never obtain concurrence from RIDEM on its closure.

NAPL Presence and Potential Impacts of Residual Oil

Based on the definition provided in Section 3.43 of the Remediation Regulations and the interpretation of the regulations presented above in Section 3.0, residual oil contamination should be considered to be NAPL only if a clearly defined separate-phase liquid is observed on groundwater or surface water under equilibrium conditions.

Applying this definition to the two evaluated NAVSTA sites: The residual oil present in soils at the OFFTA site does not constitute NAPL because a separate-phase liquid has not been observed on the groundwater or surface water under equilibrium conditions. Similarly, no separate-phase liquid has been observed or measured on the groundwater at the former Melville North Landfill site under equilibrium conditions represented by low-flow sampling or in-situ monitoring of the groundwater wells. The oil sheen observed in groundwater at the former landfill site does not constitute NAPL because the sheen was only observed in purged water produced during aggressive bailing of one well.

The residual oil present in OFFTA site soils is not acting as a significant continuing source of contamination to groundwater, surface water, or sediment. Similarly, the concentrations of residual contaminants in soils remaining at the former Melville North Landfill site are below the agreed-upon project action limits which were selected to be protective of human health and the environment.

RIDEM's Interpretation and Enforcement of Regulations Regarding NAPL

RIDEM has consistently maintained that the presence of a sheen on groundwater in test pit excavations and the presence of oily soil at and below the water table at NAVSTA sites constitute NAPL, and that presence of NAPL constitutes an exceedence of the UCLs under Section 8.07A of the RIDEM Remediation Regulations. RIDEM has also stated that a sheen on purged groundwater collected by bailing constitutes NAPL, and that to be in compliance with its regulations the Navy must demonstrate that NAPL is not present over an extended monitoring period. These statements have been made in reference to several NAVSTA sites, including OFFTA, the former Melville North Landfill, and the Tank Farms.

RIDEM personnel have asserted that RIDEM consistently enforces these interpretations of the Remediation Regulations for NAPL contamination, both at NAVSTA and elsewhere in the state (TtNUS, 2005a). Therefore, by RIDEM's broad interpretation of the regulations, a sheen on groundwater in a test pit, or in a bucket of purge water from groundwater sampling with bailers constitutes NAPL, and until all

evidence of a sheen is absent over an extended monitoring period, a remediation project can not be considered complete.

Although it is possible that RIDEM consistently enforces these interpretations of the Remediation Regulations at sites where RIDEM personnel have observed the presence of sheens or oily soil, it is unlikely that the regulations have been consistently applied to all sites in the state under RIDEM's jurisdiction. Because the observation of petroleum "stains" or "sheens" is subjective and may not always be noted in field records and reports, and RIDEM personnel can not be present to oversee all site investigations in the state and observe these conditions first-hand, it is unlikely that enforcement of the UCL for NAPL based on the presence of a sheen has been consistent at sites across the state.

6.2 Recommendations

Based on the definition provided in Section 3.43 of the Remediation Regulations and the interpretation of the Regulations presented in Section 3.0 of this evaluation, residual oil contamination should be considered to be NAPL only if a clearly defined and measurable separate-phase liquid is observed on groundwater or surface water at a site under equilibrium conditions.

Applying this interpretation, the oily soil and sheens that RIDEM has identified as NAPL at the OFFTA and former Melville North Landfill sites should not be considered to be NAPL, and therefore should not be considered to constitute exceedence of the UCLs under Section 8.07A of the Remediation Regulations.

The presence of sheens, odors, and stained soils is subjective and not quantifiable. Indeed, the purpose of collecting and evaluating chemical analytical data is to provide quantitative results on which to base evaluations of the presence and degree of adverse effects to human health and the environment. Thus, subjective, non-quantifiable observations should not, in themselves, be used to determine if a site is actionable.

Therefore, before proceeding with any remediation to address oil-contaminated soil at NAVSTA, clear and measurable endpoints must be established that all parties (Navy, RIDEM, and EPA) agree to abide by.

As always, the Navy will work with RIDEM to come to agreement on an acceptable course of action. However, if RIDEM maintains that remediation is required solely based on their assertion of the presence of NAPL, it may be necessary to appeal to EPA to follow a risk-based approach to evaluate the need for remedial action, and proceed without RIDEM's concurrence.

REFERENCES

API, 2002 Evaluating Hydrocarbon Removal from Source Zones and its Effect on Dissolved Plume Longevity and Magnitude, American Petroleum Institute, Publication Number 4715, September 2002.

API, 2003. Answers to Frequently Asked Questions About Managing Risks at LNAPL Sites, American Petroleum Institute, API Soil and Groundwater Research Bulletin Number 18, May 2003.

BRE, 1998. Source Removal Evaluation Report for Old Fire Fighting Training Area, NAVSTA, Newport, Rhode Island. Brown & Root Environmental (predecessor to Tetra Tech NUS, Inc.), January 1998.

DNREC, 2004. ASTM To Tackle Risk-Based Approach for Evaluating Non-Aqueous Phase Liquids, Delaware Department of Natural Resources and Environmental Control, Tank Management Branch, Publication Number 41, Spring 2004.

GZA, 2001. Petroleum Contaminated Soil Treatment Pilot Test, Final Report, Former Carroll Products Facility, Richmond, Rhode Island. GZA GeoEnvironmental, Inc., March 16, 2001.

LSPA, 2005. LNAPL and the Massachusetts Contingency Plan – Part I, LSP Association Technical Practices Committee, April 2005.

NOAA, 2005. Dispersant Application Observer Job Aid. National Oceanic and Atmospheric Administration, Office of Response and Restoration - Hazardous Materials Response Division. April 6, 2005.

RIDEM, 1993. Rules and Regulations for the Investigation and Remediation of Hazardous Materials Releases. (Short Title: Remediation Regulations), DEM-DSR-01-93. State of Rhode Island and Providence Plantations Department of Environmental Management, March 1993 amended August 1996 and February 2004.

RIDEM, 2005. Letter from Paul Kulpa, RIDEM Project Manager to Curt Frye, NAVFAC EFANE Project Manager, Regarding Post Removal Evaluation Report, Melville North Landfill, NAVSTA, Portsmouth, Rhode Island. July 1, 2005

TtNUS, 2002. Feasibility Study for Old Fire Fighting Training Area, NAVSTA, Newport, Rhode Island. Tetra Tech NUS, Inc., September 2002.

TtNUS, 2004. Post-Soil Removal Groundwater Evaluation for Former Melville North Landfill, NAVSTA, Newport, Rhode Island Tetra Tech NUS, Inc., October 2004.

TtNUS, 2005a Meeting notes from conference call January 13, 2005 to discuss excavation options for Old Fire Fighting Training Area, NAVSTA, Newport, Rhode Island. Participants included representatives from Navy EFANE, RIDEM, USEPA, TtNUS, Gannett Fleming, and TtFW.

TtNUS, 2005b Meeting notes from Meeting at NAVSTA, February 3, 2005 to discuss excavation options for Old Fire Fighting Training Area, NAVSTA, Newport, Rhode Island. Participants included representatives from Navy EFANE, RIDEM, USEPA, TtNUS, Gannett Fleming, and TtFW.

TtNUS, 2005c. Soil Pre-Design Investigation Report for Old Fire Fighting Training Area, NAVSTA, Newport, Rhode Island. Tetra Tech NUS, Inc., April 2005.

TtNUS, 2005d. Sediment and Groundwater Monitoring Report for Old Fire Fighting Training Area, NAVSTA, Newport, Rhode Island. Tetra Tech NUS, Inc., July 2005.

TtNUS, 2005e. Soil Pre-Design Investigation Report Addendum for Old Fire Fighting Training Area, NAVSTA, Newport, Rhode Island. Tetra Tech NUS, Inc., August 2005.